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ABSTRACT

Written for developers of classroom simulation who may wish to transfer their skills to the computer medium, this paper describes the procedures for writing and developing an educational simulation on a computer. Steps in the procedure include conceptualizing the problem to be simulated, operationalizing the variables, examining pedagogical considerations, writing the simulation manual, and simulation programming. The future for the educational simulation developer in computer simulation is also briefly discussed. References are listed. (FM)

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The Future and Educational Computer Simulation

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ABSTRACT

Developers of classroom simulation may wish to transfer their skills to the computer medium. Writing an educational computer simulation requires many of the same skills as developing a classroom simulation. The largest differences are in the resources available for communicating with the learner. The future will bring increasing importance to the quality of the educational simulation as casual learning (in the home) takes on a greater role for society.

This paper deals with the two meanings of computer simulation, how to write a computer simulation, and the new profession of educational computer simulation specialist.

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The Future and Educational Computer Simulation

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As computers and computer programmers become more sophisticated, an increasing number of educational simulations which were originally developed for the classroom are being implemented on computers (Ahl, 1978;Braun, 1972).1 Educational simulation developers need to know how to transfer their skills to the medium of computers. The thrust of the paper is that writing a simulation on a computer takes essentially the same skills as writing a classroom simulation.

Two Meanings of Classroom Simulation:

The term *computer simulation* is used to mean two different things. Let us call the most common a *Type I* simulation. It is used to predict and plan for possible future events. (Emshoff & Sisson, 1970). For example, prior to actually building a bridge, an engineer would likely simulate its behavior under extreme weather conditions and load stresses. The simulation is based on a model designed to duplicate or model exactly the real world phenomenon. That is, isomorphism between the model and the real world is necessary for the success of a Type I simulation.

In contrast, a *Type II,* or educational simulation, attempts to provide an *experience* for the learner. Examples of this type of simulation are the controlling of a nuclear power plant, the piloting of a spaceship, and the ruling of an imaginary kingdom. What is here important is the realism of the outward appearance or experience. Exactness of the final results, even validity of the final results is not as important as the feeling by the learner that the simulated experience is real.

Computer simulation of these experiences offers a number of advantages over training on real equipment (Fletcher, 1971):

[1] They are a trifle safer

[2] They cost less to operate

[3] The experience can be made available to a larger number of people

[4] They take less space

[5] It is possible to compress or expand time (You can simulate 100 years of ruling a kingdom over a cup of coffee.)

How to Write Type II Simulations

The classroom educational simulation when implemented on a computer is what we are calling a Type II simulation. How does one go about developing one? In answering this question, let us consider an example. We are going to write a computer simulation of traveling to Venus in a space ship.2

1The simulation *Dungeon* is a good example. This simulation, developed for the classroom, is now available commercially to the hobbyist and home computer markets.

2 for an actual space ship simulation, see Strickler, Buffington & Strickler, 1973. See also Atari's Star Raiders (note 1) as an example of commercially available Type II simulation.

1. Conceptualize

A likely first step is to *conceptualize* the problem. That is, we ask *what are the goals* or purposes of this exercise. In our simulation, it is to demonstrate the difficulties of space travel. Had we decided on a different goal, such as teaching astronomy, we would structure our simulation differently.

Next we list 50 to 100 possible variables in the simulation. In our space travel list we have some which we physically cannot simulate (such as zero-gravity and the forces of acceleration), some which we likely would not consider important enough to simulate (such as smells, radio sounds, changes in heat and humidity), and some which we consider essential for our goals (such as indications of speed and acceleration, and views of the target planet and the stars). We select for inclusion in our simulation the 10 to 20 variables which we consider to be essential to the success of the simulation.

2. Operationalize

Then we *operationalize* our variables. What is the relationship between acceleration and firing the thruster rockets? Since we do not know a simple formula, we express the relationship procedurally: whenever the thruster rockets are on, acceleration increases until we hit a planet at which time strange things happen.

2.1. Consider Pedagogy

In operationalizing our variables, we also examine the pedagogical considerations. How are we going to express acceleration so the learner best develops an intuitive understanding? We may wish, for example, to display this information on the video screen in the form of a gauge. By referencing a human factors textbook we take advantage of research in designing our gauge.

Since one of the goals in our simulation is to demonstrate the difficulties of space travel, we want to be sure that our rockets are no more powerful or controllable than are real rockets.

More specifically, a very important pedagogical issue is how the learner and the computer communicate. In preparing our spaceship simulation, we want to construct a realistic environment for the learner. In looking for the most realistic, we examine some possible ways for the computer to communicate with the learner.

video: Think of the video screen not as a book page for the computer to turn, but rather as a color television program, tailored to teach to the needs of this particular learner. You control what appears, when it appears, and how it appears on the screen. For example, a diagram can be shown being drawn or be flashed on the screen all in an instant, whichever would be the more effective. The screen can be made to resemble most anything, including a control panel of a spaceship and a moment later be made into a window to show the stars.

sounds: The computer can play music, produce geiger counter sounds, and make other useful sounds. In fact, nowadays even an inexpensive computer can speak a fairly fluent English.

clock: It is easy to have the time or elapsed time displayed on the screen. A Three Mile Island simulation can tick off the seconds while the helpless learner sees the reactor slowly going critical.

remote: On the market today are inexpensive products which allow tabletop computers to turn devices on and off throughout the house. In our spaceship simulation we decide to change lighting as we simulate electrical failures. Had we been more ambitious, we would have used a projector to display the changing landscapes as seen from our *spaceship window.*

Here are some ways the learner can talk to the computer:

keyboard: Typing is a primitive way to communicate. It is just not natural. (My apologies to the typist.)

light pen: Using a light pen, the learner can point to what he wants on the screen. The screen could contain words or even pictures of the alternatives. Computerists would say the screen contains a "menu" from which to select your choice.

general use: Many current home computer games use general-purpose hand held controls for their games. The joystick is typical of these controls. These are a great improvement over the keyboard. They offer simultaneous selection of rate and direction. Unfortunately, the controls are often used in an unnatural way from an psychological point of view. (You have to aim the control up to move right on the screen in one such game.)

special use: In contrast to hand-held controls which can be made adaptable for nearly every situation, special purpose controls such as foot pedals and steering wheels are extremely well suited for specific simulations and games. As special purpose devices become more available, they will become the stock in trade for educational simulation developers. The average family will have many such devices available so different simulations and games can use the same special purpose devices in the same way that general purposes devices are now used.

voice: The computer will be hearing more from you in the future. Voice recognition (the computer understanding human speech) is in its infancy for the table top computer, but it is never-the-less currently available in a primitive form.

wireless : You can hold a candy-bar sized box of buttons which communicates with a computer via ultra-sound. This device is already on the market. One can expect that soon you will be able to construct a computer simulation in which the learner is free to walk around the room while actively participating in the simulation.

2.2. Write the Manual

After deciding how the learner and the computer will communicate, the next step in operationalizing the simulation is to *write the manual* for the simulation. The manual contains not only the directions to the learner on how to operate the simulation, but also how the simulation works: the variables, the choice of inputs and outputs, and the purpose of the simulation. In doing so you will be doing the following:

* locating areas which are confusing, difficult to understand, or contradictory.
* sharing your ideas with a test group to find ways to improve it.
* clearly stating what you mean so that someone else can worry about the technical aspects of implementation.

2.3. Simulation Programming

There are a large variety of computer languages available on which to write your simulation. Regardless of the language, most of the work in programming is in deciding the procedural definitions of the variables, how they relate to other variables, and how to input and output them to and from the computer.

But you have already done this! What's more, you have already written it down. Consequently most of the planning for the computer implementation of your simulation is complete. Only the "coding" into a computer language remains, and I strongly recommend that you let a computer expert take charge from this point. The programmer will know what you want the simulation to do by reading the manual.

However, ideally, a software expert should be brought into the project at a high level at an earlier stage. A good team of specialists in educational technology, computers and the content area can produce consistently good products. Each team member brings a unique

appreciation of the problem and its solutions.

For example, consider just one contribution of the computer specialist. The software expert will try to look to construct the simulation so that it can become several simulations with just minor adjustments. This scheme was followed successfully in the *Adventure* series of simulations.

Consider a simulation on how to drive a car, written for new car drivers. Related simulations for experienced drivers could be spun-off with but minor changes. Examples of such spin-off simulations include the following:

*driving on wet pavement.

*driving on icy pavement

*night driving.

*driving with a heavy trailor

*driving a semi-truck.

*road racing.

*driving with a blown out tire.

Each team member can add a great deal to the success of a simulation. Don't go it alone.

The Future for the Educational Simulation Developer in Computer Simulation

Computer simulations are moving out of the classroom and into the home. We have to change our ways of thinking about teaching. Instead of having input into the education of hundreds, we shall soon have impact on the education of hundreds of thousands.

As casual, home education becomes more important for the American learner, there is greater need for excellence. *Sesame Street* educates millions not because it is good for people, but because it is entertaining. To educate the home audience, the simulation must appeal to the home audience.

Because of the massive size of the marketplace for home entertainment and because of the economies of mass production, there will be more and more opportunities available for people knowledgeable in educational technology to develop computer simulation. The employers will be not only the government and foundations, but also computer hardware and software firms such as Atari, Bally, and Texas Instruments. Will there be a sufficient number of educational specialists available to steer the industry on the course of excellence?

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